TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls

WACC

Item	Unit	Equity	Debt
Shares of assets	**%**	**20**	**80.0**
Expected returns after tax			
Risk-free rate of return/interest	% /a	5.0%	5.0%
Venture premium	% /a	5.0%	0.0%
Cost of capital in nominal terms, after tax	**% /a**	**10.0%**	**5.0%**
Corporate tax 25%	% /a	3.3%	0.0%
Cost of capital in nominal terms, before tax	% /a	13.3%	5.0%
WACC $_n$ **in nominal terms**	**% /a**	**6.67%**	
./. Inflation	% /a	2.0%	
WACC inflationsbereinigt, vor Steuern	**% /a**	**4.58%**	

TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls

YieldCalculation_2.4MW

Yield calculation single wind turbine

Annual average wind speed w:								5.5 m/s			30 m above ground				
Rated power output								2400 kW							
Availability								0.97							
Hub height H_N:								100 m							
Average wind speed at hub height w_N:							Z0=0.10	6.66 m/s			Roughness class 2				
w_N	**m / s**	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	**Sub - total**
P_{el}	**kW**	0	0	3	23	154	356	644	1,037	1,528	2,039	2,325	2,400	2,400	
t	**h / a**	0	305	578	793	934	996	984	912	799	666	528	401	291	
W_{el}	**MWh**	0	0	2	18	140	344	614	917	1,185	1,316	1,192	933	678	**7,338**
Continuation															
w_N	**m / s**	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	**Sub - total**
P_{el}	**kW**	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	
t	**h / a**	202.6	135.3	87	54	32	18	10	5	3	1	1	0	0	
W_{el}	**MWh**	472	315	202	125	74	42	23	0	0	0	0	0	0	**1,252**
P_{el} kW: Manufacturer's technical data									**Grand total, annual yield MWh**						**8,590**
t h/a: Frequency distribution acc. Rayleigh Model									**Capacity factor**			**40.9%**			**3,579 h/a**

TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls
Ex. 5-3_Yield_Calculation_3MW

Yield calculation single wind turbine

Annual average wind speed w:								5.5 m/s			30 m above ground				
Rated power output								3,000							
Availability								0.97							
Hub height H_N:								149 m							
Average wind speed at hub height w_N:						Z0=0.10		7.05 m/s			Roughness class 2				
w_N	m / s	0.0	1.0	2.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	**Sub -**
P_e	kW	0	0	0	49	155	339	628	1,036	1,549	2,090	2,580	2,900	3,000	**total**
t	h / a	0	273	520	799	861	933	941	894	806	693	570	450	341	
W_e	MWh	0	0	0	38	129	307	573	898	1,210	1,404	1,426	1,265	992	**8,243**
Continuation															
w_N	m / s	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	**Sub -**
P_e	kW	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	**total**
t	h / a	249	175	118	77	49	30	17	10	5	3	1	1	0	
W_e	MWh	724	509	345	225	142	86	51	29	16	8	4	2	1	**2,142**
P_e kW: Performance characteristic of the WT *)									**Grand total, annual yield MWh**						**10,385**
t h/a: Frequency distribution acc. Rayleigh Model									**Capacity factor**			**39.5%**			**3,462 h/a**

TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls
Ex. 5-4_Exceed_Probability

Item	Unit	Values	
Given			
Base case yield	GWh/a	93.3	Sqrt
Uncertainties:			
Wind data	%	15	225
Power curve	%	7	49
Fake effect	%	2	4
Standard deviation	%	-	16.7
Results			
Standard deviation	P50	-	**93.3**
Standard deviation	P90	-	**73.4**

Item	Unit	Values	
Given			
Base case yield	GWh/a	294	Sqrt
Uncertainties:			
Wind data	%	15	225
Power curve	%	7	49
Fake effect	%	2	4
Standard deviation	%	-	16.7
Results			
Standard deviation	P50	-	**294.0**
Standard deviation	P90	-	**231.2**

TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls

Ex. 5-5_CAPEX Windfarm

Item		Unit	Wind farm Capacity	
			60 MW	120 MW
Capacity				
Power output, each Wind turbine		MW	2.40	3.00
Number of Wind turbines		-	25	40
Wind farm capacity		MW	60.0	120.0
WT delivery and assembly		€ /kW	1,350	1,250
Capital costs, 2013, ± 20%				
WT delivery and assembly	100.0%	1,000 €	81,000	150,000
Civil works	3.0%	1,000 €	2,430	4,500
Foundations	4.0%	1,000 €	3,240	6,000
Internal electrical wiring	5.0%	1,000 €	4,050	7,500
Grid connection, 110 kV	5.5%	1,000 €	4,460	8,250
Project development, engineering	5.0%	1,000 €	4,050	7,500
Contingencies	5.0%	1,000 €	4,050	7,500
Total		**1,000 €**	**103,280**	**191,250**
Specific cost		**€ /kW**	**1,720**	**1,590**

TE-Ch5.2_REN-Windpower-Ex-5-3-to-5-6.xls

Item			Unit	Wind farm Capacity	
				60 MW	120 MW
Technical, Operational parameters					
Average wind speed, 30 m above ground			m / s	5.5	5.5
Electrical capacity of each WT			kW	2,400	3,000
Number of wind turbines			Stck.	25	40
Energy yield of each WT			MWh/a	8,590	10,385
Total gross energy yield of the wind farm			MW	60.0	120.0
Energy losses of the wind farm			%	14%	13%
Electricity production, net			MWh/a	184,690	361,399
Full load hours			h/a	3,078	3,012
Technical, economic parameters					
Life time			a	20	20
Construction time			a	1.50	2.00
Inflation			%	2.0%	2.0%
Discount rate in real terms (WACC) *)			%	4.58%	4.58%
Maintenance contract			Cent / kWh	1.00	1.00
Management/technical surveillance			% CAPEX / a	1.3%	1.3%
Insurance			% CAPEX / a	0.5%	0.5%
Reserves for decommissioning			% CAPEX / a	0.8%	0.8%
Operating staff	0.1 Pers/WKA		Pers/a	3	4
Costs of personnel	70 th. €/pers.a		1,000 €	175	280
Leasing costs for site			Cent / kWh	0.35	0.35
CAPEX estimate, 2013 prices, ±20%	in % of WT		**1,000 €**	**103,280**	**191,250**
Calculation with escalation (yes or no)	no	0			
Operating Costs	esc rates*)		**1,000 €**	**5,354**	**10,131**
Maintenance contract	1.5%/a	1.00	1,000 €	1,847	3,614
Management/technical surveillance	2.0%/a	1.00	1,000 €	1,343	2,486
Insurance	0.0%/a	1.00	1,000 €	516	956
Reserves for decommissioning	0.0%/a	1.00	1,000 €	826	1,530
Costs of personnel	1.5%/a	1.00	1,000 €	175	280
Leasing costs for site	0.0%/a	1.00	1,000 €	646	1,265
Annualized CAPEX			**1,000 €**	7,642	14,151
Total annual costs			**1,000 €**	**12,996**	**24,282**
Specific electricity generation cost			**€ / MWh**	**70.36**	**67.19**

*) inflation adjusted, in real terms